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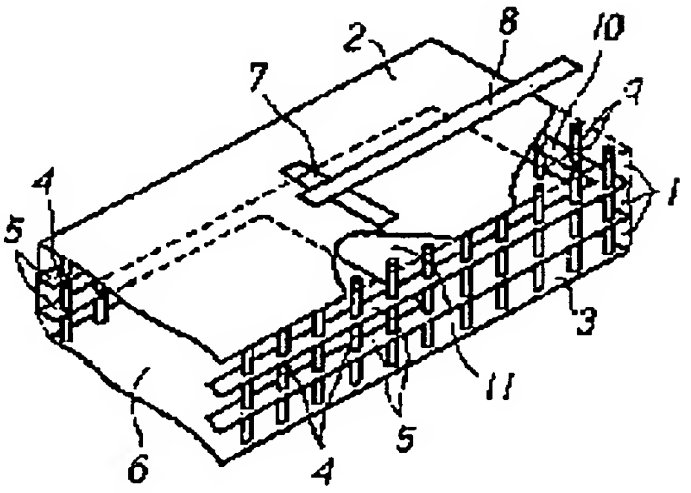
## (54) CONNECTION STRUCTURE BETWEEN DIELECTRIC WAVEGUIDE LINE AND HIGH FREQUENCY LINE CONDUCTOR

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a connection structure between a dielectric waveguide line and a high frequency line conductor electromagntically connecting the stacked dielectric waveguide line and the high frequency line conductor such as other microstrip line or coplanar line through the use of a slot hole 7 while keeping an excellent characteristic even when the characteristic impedance of the both differs.
SOLUTION: The connection structure is configured such that a high frequency line conductor 8 placed opposite to a slot hole 7 is electromagnetically coupled with a dielectric waveguide line 6 provided with main conductor layers 2, 3 clamping a dielectric board 1, two-lines of side wall use through-conductor groups 4, and a sub conductor layer 5 in parallel with the main conductor layers 2, 3, a short-circuit end by end face use through-conductor groups 9 and an end face use sub conductor layer 10 is formed at a position distant from the slot hole 7 of the dielectric waveguide line 6 by about a multiple of n/2 of a guide wavelength in a transmission direction, and an inner conductor layer 11 reaching a lower part of the slot hole 7 from a short-circuit end is formed at a height from the main conductor layer 3 by less than 1/4 of the waveguide length. The characteristic impedance of the connected parts of the both can be matched by using the short circuit end and the inner conductor 11 and the connection structure with an excellent characteristic is realized by suppressing the reflection.

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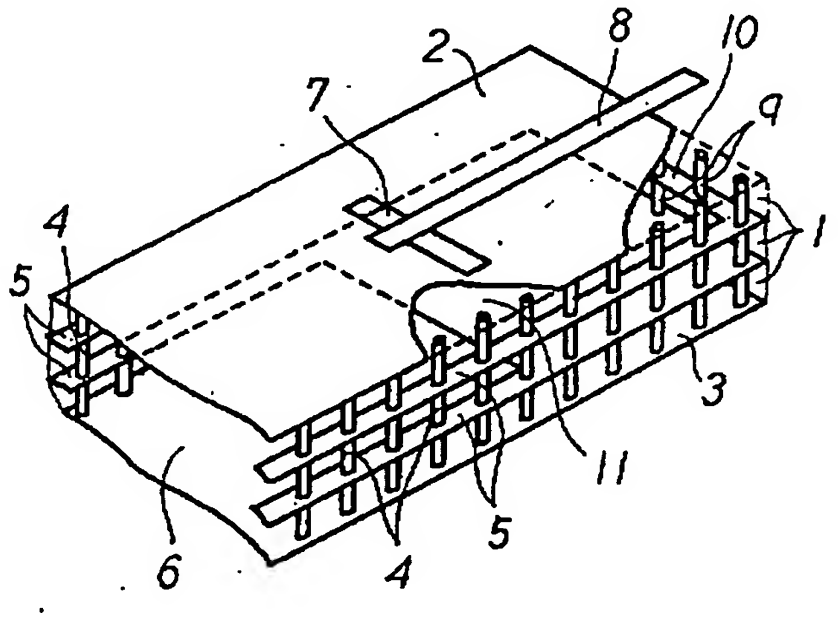
(54)【発明の名称】　誘電体導波管線路と高周波線路導体との接続構造

(57)【要約】
【課題】　誘電体導波管線路に形成したスロット孔のみによる電磁結合では、様々な特性インピーダンスの高周波線路導体と良好な特性で接続できない。
【解決手段】　誘電体基板１を挟持する主導体層２・３と、２列の側壁用貫通導体群４と、主導体層２・３と平行な副導体層５とを具備してなる誘電体導波管線路６に対して、スロット孔７に対向配置した高周波線路導体８を電磁結合させるとともに、誘電体導波管線路６のスロット孔７から伝送方向に管内波長の略２分の１のｎ倍の位置に端面用貫通導体群９と端面用副導体層10とによる短絡端を形成し、かつ主導体層３から管内波長の４分の１未満の高さに短絡端からスロット孔７の下部に至る内部導体層11を形成した接続構造である。短絡端と内部導体層11とで接続部の特性インピーダンスを整合させることができ、反射を抑えて良好な特性の接続構造とすることができる。



【特許請求の範囲】

【請求項１】　誘電体基板を挟持する一対の主導体層と、該主導体層間を高周波信号の伝送方向に信号波長の２分の１未満の繰り返し間隔および所定の幅で電気的に接続する２列の側壁用貫通導体群と、前記主導体層間に平行に形成され、前記側壁用貫通導体群をそれぞれ電気的に接続する一対の副導体層と、前記主導体層の一方に形成したスロット孔と、該スロット孔から前記伝送方向に管内波長の略２分の１のｎ倍（ｎは自然数）の位置において前記主導体層間を前記幅方向に前記信号波長の２分の１未満の繰り返し間隔で電気的に接続する端面用貫通導体群と、該端面用貫通導体群および前記一対の副導体層と電気的に接続された端面用副導体層と、前記端面用貫通導体群に電気的に接続され、前記主導体層の他方から前記管内波長の４分の１未満の高さの位置に平行に前記スロット孔の下部まで形成された内部導体層とを具備して成る誘電体導波管線路に、前記スロット孔に対向配置した高周波線路導体を電磁結合させたことを特徴とする誘電体導波管線路と高周波線路導体との接続構造。

【請求項２】　誘電体基板を挟持する一対の主導体層と、該主導体層間を高周波信号の伝送方向に信号波長の２分の１未満の繰り返し間隔および所定の幅で電気的に接続する２列の側壁用貫通導体群と、前記主導体層間に平行に形成され、前記側壁用貫通導体群をそれぞれ電気的に接続する一対の副導体層と、前記主導体層の一方に形成したスロット孔と、該スロット孔から前記伝送方向に管内波長の略２分の１のｎ倍（ｎは自然数）の位置において前記主導体層間を前記幅方向に前記信号波長の２分の１未満の繰り返し間隔で電気的に接続する端面用貫通導体群と、該端面用貫通導体群および前記一対の副導体層と電気的に接続された端面用副導体層と、一端が前記端面用貫通導体群に電気的に接続され、前記主導体層に平行に前記スロット孔の下部まで形成された内部導体層と、該内部導体層の他端と前記主導体層の他方とを前記管内波長の２分の１未満の繰り返し間隔で電気的に接続する内部貫通導体群とを具備して成る誘電体導波管線路に、前記スロット孔に対向配置した高周波線路導体を電磁結合させたことを特徴とする誘電体導波管線路と高周波線路導体との接続構造。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、主にマイクロ波やミリ波等の高周波信号を伝送する誘電体導波管線路と高周波線路導体との接続構造に関し、特に、誘電体導波管線路と高周波線路導体とをスロット孔を介して電磁的に接続した接続構造に関するものである。

【０００２】

【従来の技術】近年、マイクロ波帯やミリ波帯等の高周波信号を用いた移動体通信および車間レーダ等の研究が盛んに進められている。これらの高周波回路において高



周波信号を伝送するための高周波伝送線路としては、従来より、同軸線路や方形導波管・誘電体導波管・マイクロストリップ線路等の線路導体等が知られている。

【０００３】また、最近では、高周波回路を構成する配線回路内には高周波信号を伝送するために上記の高周波伝送線路やアンテナ素子等の種類の異なる高周波線路が複数配置されるために、これら高周波線路相互間の接続技術が必要となっており、これについて様々な構造の接続構造が報告されている。

【０００４】例えば、同軸線路と方形導波管または誘電体導波管との接続構造では、同軸線路の信号線を導波管内に挿入して高周波的に結合することによって接続される。

【０００５】また、導波管とマイクロストリップ線路との接続構造では、例えば導波管とマイクロストリップ線路とを直角に接続する場合には、導波管内にマイクロストリップ線路の形成された誘電体基板を挿入する構造が用いられる。また、導波管とマイクロストリップ線路とを同じ伝送方向で接続する場合には、導波管としてマイクロストリップ線路が接続される端部へ向かってその幅を曲線状に狭くしたいわゆるリッジ導波管を用い、その内部にマイクロストリップ線路の信号線を挿入する構造や、導波管または誘電体導波管にスロット孔を設け、スロット孔を介した電磁結合により接続する構造などが提案されている。

【０００６】

【発明が解決しようとする課題】最近に至り、高周波回路を構成する基板上または基板内に形成すると小型化の面で有利となることから、多層配線基板内に誘電体導波線路を積層技術によって形成することが望まれている。例えば、特開平６－53711 号においては、誘電体基板を一対の主導体層で挟み、さらに主導体層間を接続する２列に配設されたビアホール群によって側壁を形成した導波管線路が提案されている。この導波管線路は誘電体材料の四方を一対の主導体層とビアホール群による擬似的な導体壁で囲むことによって導体壁内の領域を信号伝送用の線路としたものである。

【０００７】このような多層配線基板の内部に配設される積層型の誘電体導波管線路を、主にマイクロ波およびミリ波用のセラミック多層配線基板あるいは高周波用半導体パッケージの伝送線路として用いる上では、他の高周波線路との接続が必要になる。

【０００８】これに対し、本発明者は既に特開平10－107518号公報において、図Ａに部分破断斜視図で概略構成を示すような、スロット孔による電磁的な結合を用いた接続構造を提案している。図Ａによれば、誘電体１を挟んで所定の間隔をもって少なくとも線路形成位置を挟む上下面に一対の主導体層２・３が平行に形成されている。なお、内部の構造が分かるように、主導体層２の一部は破断して示している。また、主導体層２・３間に

は、それらを電気的に接続する貫通導体群４が設けられている。貫通導体群４は、所定の間隔（幅）をもって２列に配列され、かつ貫通導体のそれぞれは高周波信号の伝送方向、つまり線路形成方向に信号波長の２分の１未満の間隔をもって形成されている。これにより、主導体層２・３と貫通導体群４とで囲まれる領域が誘電体導波管線路５となる。また、主導体層２・３の間には、誘電体導波管線路５の側壁を形成する貫通導体群４と電気的に接続され、主導体層２・３と平行に形成された副導体層６が形成されており、線路の側壁を格子状として電磁波の遮蔽効果を高めている。そして、主導体層２・３のうち少なくとも一方、ここでは上側の主導体層２に、導体を形成しないスロット孔７を形成しており、このスロット孔７を介して誘電体導波管線路５と他の例えばマイクロストリップ線路等の高周波線路導体（図示せず）と接続するものである。

【０００９】この接続構造によれば、主導体層２・３の一部にスロット孔７を形成することにより容易に他の高周波線路導体と電磁結合することができ、しかも、かかる構造を有する誘電体導波管線路５およびそれを使用した多層配線基板は、従来のセラミック積層技術を応用して容易に作製することができる。

【００１０】しかしながら、このような積層型の誘電体導波管線路５の特性インピーダンスとスロット孔７を介して接続される他の高周波線路導体との特性インピーダンスとは通常は一致していない。そのため、かかる接続部において特性インピーダンスの不一致による高周波信号の反射が発生し、同時に透過特性も劣化するという問題点があった。

【００１１】本発明は上記従来技術の問題点に鑑みて案出されたものであり、その目的は、積層型の誘電体導波管線路と、他のマイクロストリップ線路やコプレーナ線路等の高周波線路導体とをスロット孔を用いて電磁的に結合し、両者の特性インピーダンスが異なるものであっても良好な特性で接続することができる誘電体導波管線路と高周波線路導体との接続構造を提供することにある。

【００１２】

【課題を解決するための手段】本発明者は、上記の問題点に対して検討を重ねた結果、誘電体導波管線路の主導体層に形成したスロット孔から所定の位置に誘電体導波管線路の短絡端を形成するとともに、この短絡端からスロット孔の下部に至る、高周波線路導体と平行に対向する内部導体層を主導体層間に形成することにより、この内部導体層が特性インピーダンスの整合用導体層として機能し、接続部において優れた透過特性が得られることを見出した。

【００１３】すなわち、本発明の誘電体導波管線路と高周波線路導体との接続構造は、誘電体基板を挟持する一対の主導体層と、この主導体層間を高周波信号の伝送方向に信号波長の２分の１未満の繰り返し間隔および所定の幅で電気的に接続する２列の側壁用貫通導体群と、前記主導体層間に平行に形成され、前記側壁用貫通導体群をそれぞれ電気的に接続する一対の副導体層と、前記主導体層の一方に形成したスロット孔と、このスロット孔から前記伝送方向に管内波長の略２分の１のｎ倍（ｎは自然数）の位置において前記主導体層間を前記幅方向に前記信号波長の２分の１未満の繰り返し間隔で電気的に接続する端面用貫通導体群と、この端面用貫通導体群および前記一対の副導体層と電気的に接続された端面用副導体層と、前記端面用貫通導体群に電気的に接続され、前記主導体層の他方から前記管内波長の４分の１未満の高さの位置に平行に前記スロット孔の下部まで形成された内部導体層とを具備して成る誘電体導波管線路に、前記スロット孔に対向配置した高周波線路導体を電磁結合させたことを特徴とするものである。



【００１４】また、本発明の誘電体導波管線路と高周波線路導体との接続構造は、誘電体基板を挟持する一対の主導体層と、この主導体層間を高周波信号の伝送方向に信号波長の２分の１未満の繰り返し間隔および所定の幅で電気的に接続する２列の側壁用貫通導体群と、前記主導体層間に平行に形成され、前記側壁用貫通導体群をそれぞれ電気的に接続する一対の副導体層と、前記主導体層の一方に形成したスロット孔と、このスロット孔から前記伝送方向に管内波長の略２分の１のｎ倍（ｎは自然数）の位置において前記主導体層間を前記幅方向に前記信号波長の２分の１未満の繰り返し間隔で電気的に接続する端面用貫通導体群と、この端面用貫通導体群および前記一対の副導体層と電気的に接続された端面用副導体層と、一端が前記端面用貫通導体群に電気的に接続され、前記主導体層に平行に前記スロット孔の下部まで形成された内部導体層と、この内部導体層の他端と前記主導体層の他方とを前記管内波長の２分の１未満の繰り返し間隔で電気的に接続する内部貫通導体群とを具備して成る誘電体導波管線路に、前記スロット孔に対向配置した高周波線路導体を電磁結合させたことを特徴とするものである。

【００１５】本発明の誘電体導波管線路と高周波線路導体との接続構造によれば、誘電体導波管線路のスロット孔から所定の位置に短絡端を形成するとともに、この短絡端からスロット孔の下部までの間の所定位置に、主導体層間と平行に高周波線路導体と対向させて内部導体層を形成し、また、その端部を主導体層と電気的に接続する内部貫通導体群を形成したことにより、この部分の誘電体導波管線路の実効的な厚みが変化することとなり、それにより、高周波線路導体との接続部の特性インピーダンスが変化して、誘電体導波管線路と高周波線路導体との特性インピーダンスマッチングをとることが可能となる。そして、両者の特性インピーダンスを整合させることにより、接続部における高周波信号の反射の発生を

充分に低減させて良好な透過特性が得られる接続構造となる。しかも、このような整合器として機能する内部導体層ならびに内部貫通導体群は、従来のセラミック積層技術や同時焼成技術により、誘電体導波管線路と一体的に同時に製作することができ、量産性にも優れている。

【００１６】

【発明の実施の形態】以下、本発明の誘電体導波管線路と高周波線路導体との接続構造について図面を参照しながら説明する。

【００１７】図１は、本発明の誘電体導波管線路と高周波線路導体との接続構造の実施の形態の一例を示す部分破断斜視図である。図１において１は誘電体基板、２および３は誘電体基板１を上下から挟持する一対の主導体層、４は信号伝送方向に信号波長の２分の１未満の繰り返し間隔で、かつ信号伝送方向と直交する方向に所定の幅で一対の主導体層２・３間を電気的に接続するように形成された２列の側壁用貫通導体群である。なお、内部の構造が分かるように、主導体層２の一部は破断して示している。また、５は側壁用貫通導体群４の各列を形成する貫通導体同士を電気的に接続する、主導体層２・３と平行に形成された副導体層である。６はこれら一対の主導体層２・３と側壁用貫通導体群４および副導体層５により形成される誘電体導波管線路である。

【００１８】このように、所定の厚みの誘電体基板１を挟持する少なくとも伝送線路形成位置を挟む上下面に一対の主導体層２・３が形成されるとともに、２列の側壁用貫通導体群４が形成されており、この一対の主導体層２・３と側壁用貫通導体群４とで囲まれた領域に対してさらに副導体層５を形成することにより、誘電体導波管線路６の内部から見るとその側壁は側壁用貫通導体群４と副導体層５とによって細かな格子状になり、様々な方向の電磁波が遮蔽される。

【００１９】７は上側の主導体層２に形成したスロット孔であり、このスロット孔７に対して上側の主導体層２に平行に配設された高周波線路導体８を対向させて、誘電体導波管線路６と高周波線路導体８とがスロット孔７を介して電磁結合することにより接続され、高周波信号が伝達されることとなる。

【００２０】なお、この例では高周波線路導体８に対する接地面は誘電体導波管線路６の主導体層２の一部で兼ねた構成となっている。この場合、高周波線路導体８と主導体層２との間は、空気であっても誘電体であってもよい。また、高周波線路導体８は、裏面に接地層が形成された別の誘電体基板の上に形成されたもの（マイクロストリップ線路）でもよく、誘電体基板の表面に同一面接地層とともに形成されたもの（コプレーナ線路）でもよい。

【００２１】９は、誘電体導波管線路６のスロット孔７から高周波信号の伝送方向に管内波長λｇの略２分の１のｎ倍（～ｎ×λｇ／２、ｎは自然数）の位置に、伝送方向の直交方向に信号波長の２分の１未満の間隔で主導体層２・３間を電気的に接続して形成された端面用貫通導体群である。また、10は主導体層２・３間に主導体層２・３と平行に形成され、副導体層５および端面用貫通導体群９と電気的に接続された端面用副導体層である。これら端面用貫通導体群９と端面用副導体層10とにより、誘電体導波管線路６のスロット孔７から～ｎ×λｇ／２の位置に、誘電体導波管線路６の短絡端を形成している。



【００２２】そして、11は、下側の主導体層３から高周波信号の管内波長の４分の１未満の高さの位置に、主導体層２・３と平行に高周波線路導体８に対向させて、その一端が端面用貫通導体群９に電気的に接続され、他端がスロット孔７の下部に至る内部導体層である。このように、誘電体導波管線路６の短絡端を形成するとともに、その短絡端からスロット孔７の下部に至る内部導体層11を形成したことにより、この内部導体層11の下側すなわち主導体層３との間には高周波信号が侵入することができず、スロット孔７から短絡端までの誘電体導波管線路６の厚みを薄くしたことと同様の結果となる。そこで、この内部導体層11を形成する高さを調整し、また幅や長さを調整することにより、接続部において誘電体導波管線路６と高周波線路導体８とのインピーダンスをマッチングさせることができ、接続部における伝送信号の反射を充分に低減させるとともに良好な透過特性が得られるものとなる。

【００２３】このような図１に示す構成の本発明の誘電体導波管線路と高周波線路導体との接続構造は、誘電体基板を上下から挟持する一対の主導体層と、高周波信号の伝送方向に信号波長の２分の１未満の繰り返し間隔で、かつ前記伝送方向と直交する方向に所定の幅で前記主導体層間を電気的に接続して形成された２列の側壁用貫通導体群と、前記主導体層間に主導体層と平行に形成され、前記側壁用貫通導体群と電気的に接続された副導体層とを具備して成り、前記主導体層、側壁用貫通導体群および副導体層で囲まれた領域によって高周波信号を伝送する誘電体導波管線路に対して、上側の前記主導体層に平行に配設された高周波信号を伝送する高周波線路導体を上側の前記主導体層に形成したスロット孔を介して対向させて電磁的に結合させるとともに、前記スロット孔から前記伝送方向に管内波長の略２分の１のｎ倍（ｎは自然数）の位置に、伝送方向の直交方向に前記信号波長の２分の１未満の間隔で前記主導体層間を電気的に接続して形成された端面用貫通導体群と、前記主導体層間に主導体層と平行に形成され、前記副導体層および前記端面用貫通導体群と電気的に接続された端面用副導体層とから成る短絡端を形成し、かつ、下側の前記主導体層から前記管内波長の４分の１未満の高さの位置に前記主導体層と平行に前記高周波線路導体に対向させて、一端が前記端面用貫通導体群に電気的に接続され他端が

前記スロット孔の下部に至る内部導体層を形成したものである。

【００２４】なお、図１において内部導体層11は一端を端面用副導体層10と一体化させ、両側を副導体層５と一体化させて形成しているが、内部導体層11を形成する高さは副導体層５・10と合わせる必要はなく、また、幅も少なくとも高周波線路導体８に対向する幅があればよい。

【００２５】例えば、図１に示す例では誘電体基板１を３層構造として誘電体導波管線路６を構成し、１層目の誘電体基板１の上に内部導体層11を形成しているが、誘電体基板の各層の厚みを調整したり積層数を調整することにより、任意の高さの位置に内部導体層11を設けることができる。

【００２６】また、内部導体層11の長さとしては、短絡端からスロット孔７の下部に至るものとして設定されるが、その他端がスロット孔７の中央から短絡端と反対側に約λｇ／８の位置にくるように形成することが望ましい。

【００２７】２列の側壁用貫通導体群４は、高周波信号の伝送方向すなわち線路形成方向に信号波長の２分の１未満の所定の繰り返し間隔で、かつ伝送方向と直交する方向に所定の一定の間隔（幅）をもって形成されている。これにより、この誘電体導波管線路６における電気的な側壁を形成することとなって電磁波は誘電体導波管線路６に対して垂直方向に伝播することができず、反射しながら誘電体導波管線路６の信号伝送方向に伝播される。その結果、図１のような構成によれば、一対の主導体層２・３と２列の側壁用貫通導体群４および副導体層５とによって囲まれる領域が誘電体導波管線路６となる。

【００２８】ここで、誘電体基板１の厚みすなわち一対の主導体層２・３間の間隔に対する制限は特にないが、シングルモードで用いる場合には側壁用貫通導体群４の幅に対して２分の１程度または２倍程度とすることがよい。図１の例では誘電体導波管線路６のＨ面に当たる部分が主導体層２・３で、Ｅ面に当たる部分が側壁用貫通導体群４および副導体層５でそれぞれ形成される。また、側壁用貫通導体群４の幅に対して誘電体基板１の厚みを２倍程度とすれば、誘電体導波管線路６のＥ面に当たる部分が主導体層２・３で、Ｈ面に当たる部分が側壁用貫通導体群４および副導体層５でそれぞれ形成されることとなる。

【００２９】また、貫通導体の繰り返し間隔が信号波長の２分の１未満の間隔に設定されることで、側壁用貫通導体群４により電気的な壁が形成できる。この間隔は、望ましくは信号波長の４分の１未満である。

【００３０】平行に配置された一対の主導体層２・３間にはＴＥＭ波が伝播できるため、側壁用貫通導体群４の各列における貫通導体の繰り返し間隔が信号波長λの２分の１（λ／２）よりも大きいと、その隙間がスロットとして作用して電磁波が漏れるので、この誘電体導波管線路６に電磁波を給電しても電磁波は側壁用貫通導体群４の間から漏れてしまい、ここで作られる疑似的な導波管線路に沿って伝播しない。しかし、側壁用貫通導体群４の繰り返し間隔がλ／２よりも小さいと、電気的な側壁を形成することとなって電磁波は誘電体導波管線路６に対して垂直方向に伝播することができず、反射しながら誘電体導波管線路６の信号伝送方向に伝播される。その結果、図１のような構成によれば、一対の主導体層２・３と２列の側壁用貫通導体群４および副導体層５とによって囲まれる領域が誘電体導波管線路６となる。

【００３１】そして、この誘電体導波管線路６中を伝播する高周波信号は、その一部または全部が、主導体層２に形成されたスロット孔７を介してスロット孔７の上部に対向して配置される様々な高周波線路導体８と電磁的に結合して伝播することとなる。

【００３２】図１に示した態様では側壁用貫通導体群４は２列に形成したが、この側壁用貫通導体群４を４列あるいは６列に配設して、側壁用貫通導体群４による疑似的な導体壁を２重・３重に形成することにより導体壁からの電磁波の漏れをより効果的に防止することもできる。

【００３３】このような誘電体導波管線路６によれば、誘電体導波管による伝送線路となるので、誘電体基板１の比誘電率を$\varepsilon_r$とするとその導波管サイズは通常の導波管の$1/\sqrt{\varepsilon_r}$の大きさになる。従って、誘電体基板１を構成する材料の比誘電率$\varepsilon_r$を大きいものとするほど導波管サイズを小さくすることができて高周波回路の小型化を図ることができ、高密度に配線が形成される多層配線基板または半導体素子収納用パッケージあるいは車間レーダの伝送線路としても利用可能な大きさの誘電体導波管線路６とすることができる。

【００３４】なお、側壁用貫通導体群４を構成する貫通導体は前述のように信号波長の２分の１未満の繰り返し間隔で配設されており、この繰り返し間隔は良好な伝送特性を実現するためには一定の繰り返し間隔とすることが望ましいが、信号波長の２分の１未満の間隔であれば、適宜変化させたりいくつかの値を組み合わせたりしてもよい。

【００３５】このような誘電体導波管線路６を構成する誘電体基板１としては、誘電体として機能し高周波信号の伝送を妨げることのない特性を有するものであればとりわけ限定するものではないが、伝送線路を形成する際の精度および製造の容易性の点からは、誘電体基板１はセラミックスから成ることが望ましい。

【００３６】このようなセラミックスとしてはこれまで様々な比誘電率を持つセラミックスが知られているが、本発明に係る誘電体導波管線路によって高周波信号を伝送するためには常誘電体であることが望ましい。これは、一般に強誘電体セラミックスは高周波領域では誘電損失が大きく伝送損失が大きくなるためである。従って、誘電体基板１の比誘電率$\varepsilon_r$は４～100 程度が適当である。

【００３７】また、一般に多層配線基板や半導体素子収納用パッケージあるいは車間レーダに形成される配線層

の線幅は最大でも１mm程度であることから、比誘電率が100 の材料を用い、上部がH面すなわち磁界が上側の面に平行に巻く電磁界分布になるように用いた場合は、用いることのできる最小の周波数は15GHz と算出され、マイクロ波帯の領域でも利用可能となる。

【００３８】一方、一般的に誘電体基板１として用いられる樹脂からなる誘電体は、比誘電率$\varepsilon_r$が２程度であるため、線幅が１mmの場合は約100 GHz 以上でないと利用することができないものとなる。

【００３９】また、このような常誘電体セラミックスの中にはアルミナやシリカ等のように誘電正接が非常に小さなものが多いが、全ての常誘電体セラミックスが利用可能であるわけではない。誘電体導波管線路の場合は導体による損失はほとんどなく、信号伝送時の損失のほとんどは誘電体による損失である。その誘電体による損失α（ｄＢ／ｍ）は次のように表わされる。

$$\alpha = 27.3 \times \tan\delta / [\lambda / \{1 - (\lambda/\lambda c)^2\}^{1/2}]$$

式中、tanδ：誘電体の誘電正接

λ　　：誘電体中の波長

λc　　：遮断波長

規格化された矩形導波管（ＷＲＪシリーズ）形状に準ずると、上式中の$\{1 - (\lambda/\lambda c)^2\}^{1/2}$は0.75程度である。

【００４０】従って、実用に供し得る伝送損失である－100 ｄＢ／ｍ以下にするには、次の関係が成立するように誘電体を選択することが必要である。

$$f \times \varepsilon_r^{1/2} \times \tan\delta \leqq 0.8$$

式中、ｆは使用する高周波信号の周波数（ＧＨｚ）である。

【００４１】このような誘電体基板１としては、例えばアルミナセラミックスや窒化アルミニウムセラミックス・ガラスセラミックス等がある。これらによる誘電体基板１は、例えばセラミックス原料粉末に適当な有機溶剤・溶媒を添加混合して泥漿状になすとともに、これを従来周知のドクターブレード法やカレンダーロール法等を採用してシート状となすことによって複数枚のセラミックグリーンシートを得て、しかる後、これらセラミックグリーンシートの各々に適当な打ち抜き加工を施すとともにこれらを積層し、アルミナセラミックスの場合は1500～1700℃、ガラスセラミックスの場合は850 ～1000℃、窒化アルミニウムセラミックスの場合は1600～1900℃の温度で焼成することによって製作される。

【００４２】また、一対の主導体層２・３および副導体層５は、例えば誘電体基板１がアルミナセラミックスから成る場合には、タングステン等の金属粉末に適当なアルミナ・シリカ・マグネシア等の酸化物や有機溶剤・溶媒等を添加混合してペースト状にしたものを用いて厚膜印刷法により少なくとも伝送線路を完全に覆うようにセラミックグリーンシート上に印刷し、しかる後、約1600



℃の高温で焼成し、厚み５～15μm程度となるようにして形成する。なお、金属粉末としては、ガラスセラミックスの場合は銅・金・銀が、窒化アルミニウムセラミックスの場合はタングステン・モリブデンが好適である。また、主導体層２・３および副導体層５の厚みは一般的に５～15μm程度とされる。

【００４３】また、側壁用貫通導体群４を構成する貫通導体は、例えばビアホール導体やスルーホール導体等により形成すればよい。その断面形状は製作が容易な円形の他、矩形や菱形等の多角形であってもよい。これら貫通導体は、例えばセラミックグリーンシートに打ち抜き加工を施して作製した貫通孔に主導体層２・３と同様の金属ペーストを埋め込み、しかる後、誘電体基板１と同時に焼成して形成する。なお、貫通導体は直径50～300μmが適当である。また、上側の主導体層２に形成するスロット孔７は、これに対向して主導体層２の上部に主導体層２と平行に配設される高周波線路導体８と誘電体導波管線路６とを電磁的に結合して高周波信号の接続を行なうものである。このスロット孔７を形成する位置や形状・大きさ等は、次のように設定される。

【００４４】スロット孔７の形状は、長さが信号波長の２分の１、幅が長さの３分の１から10分の１程度とした長方形状とすればよい。また、スロット孔７の位置は、誘電体導波管線路６と高周波線路導体８とが電磁界により電磁結合ができる位置関係にあればよい。具体的には、高周波線路導体８がマイクロストリップ線路やコプレーナ線路等の場合は、スロット孔７の長手方向と完全に平行でなければ結合され、直交する場合に最も良好に結合される。

【００４５】そして、図１に示すように、本発明の接続構造にかかる誘電体導波管線路６においては、誘電体導波管線路６のスロット孔７から伝送方向に管内波長の略２分の１のｎ倍（ｎは自然数）の位置に、端面用貫通導体群９と端面用副導体層10とから成る短絡端を形成するとともに、下側の主導体層３から管内波長の４分の１未満の高さの位置に短絡端からスロット孔７の下部に至る内部導体層11を形成することにより、スロット孔７から短絡端までの部分に、４分の１波長整合回路として機能する、誘電体導波管線路６の厚みを薄くした部分を形成していることが特徴である。これにより、整合回路部分の厚みを調整することによってこの部分の特性インピーダンスを調節することが可能となり、スロット孔７を介して特性インピーダンスの異なる高周波線路導体８を低反射の状態で電磁結合させることができる。このような整合回路部分の厚みの調整は、内部導体層11の位置や幅・長さを調整して設けることにより行なうことができる。

【００４６】このように誘電体導波管線路６の整合回路部分を形成したことにより、他の種々の高周波線路導体８と誘電体導波管線路６とを高性能で接続することがで

き、しかも、この整合回路部分は高周波用多層配線基板や高周波用半導体素子収納用パッケージを構成する誘電体基板内にグリーンシート積層法等のシート積層技術により容易に作製して作り込むことができるので、生産性が高く安価な製造が可能な接続構造となる。

【００４７】次に、図２に本発明の誘電体導波管線路と高周波線路導体との接続構造の実施の形態の他の例を図１と同様の部分破断斜視図で示す。

【００４８】図２において図１と同様の箇所には同じ符号を付してある。図２において、12は、図１における内部導体層11に代えて形成した、主導体層２・３間に主導体層と平行に高周波線路導体８に対向させて、一端が端面用貫通導体群９に電気的に接続され、他端がスロット孔７の下部に至る内部導体層であり、13は、高周波信号の管内波長の２分の１未満の繰り返し間隔で内部導体層12の他端とその下側の主導体層３とを電気的に接続するように形成した内部貫通導体群である。

【００４９】このような内部導体層12と内部貫通導体群13とを形成したことにより、内部導体層12の高さが下側の主導体層３から管内波長の４分の１を越えるものとなっても、スロット孔７の下部に位置する内部導体層12の他端側からの内部導体層12の下側への伝送信号の侵入は内部貫通導体群13により阻止されるので、図１に示す接続構造の例に比べて、より電気的に安定した、しかも内部導体層12の高さの設定可能な範囲がより広範囲となった整合回路部分を構成することができる。これにより、この内部導体層12を形成する高さを調整し、また幅や長さを調整することにより、接続部において誘電体導波管線路６と高周波線路導体８とのインピーダンスをより良好にマッチングさせることができ、接続部における伝送信号の反射をより効果的に低減させるとともに極めて良好な透過特性が得られるものとなる。

【００５０】このような接続構造において、内部導体層12とともに整合回路部分を構成する内部貫通導体群13は、その繰り返し間隔を管内波長の２分の１より小さくしておくとその貫通導体間からの電磁波の漏れがなくなることとなるため、内部貫通導体群13の間隔は管内波長の２分の１未満であることが必要である。なお、図２の例では内部貫通導体群13を内部導体層12の他端に沿って１列に配置したが、これを複数列に配置してもよく、また、いわゆる千鳥状に配置してもよい。

【００５１】また、内部導体層12については、内部導体層11と同様に、この内部導体層12の伝送方向の長さは～ｎ×λｇ／２となることから、この部分が誘電体導波管線路６と高周波線路導体８との接続部における両者のインピーダンスの整合器として機能するものとなる。その結果、この内部導体層12を形成する高さを調整し、また幅や長さを調整することにより、接続部において誘電体導波管線路６と高周波線路導体８とのインピーダンスを良好にマッチングさせることができ、接続部における伝送信号の反射をより充分に低減させるとともに極めて良好な透過特性が得られるものとなる。



【００５２】このような図２に示す構成の本発明の誘電体導波管線路と高周波線路導体との接続構造は、誘電体基板を上下から挟持する一対の主導体層と、高周波信号の伝送方向に信号波長の２分の１未満の繰り返し間隔で、かつ前記伝送方向と直交する方向に所定の幅で前記主導体層間を電気的に接続して形成された２列の側壁用貫通導体群と、前記主導体層間に主導体層と平行に形成され、前記側壁用貫通導体群と電気的に接続された副導体層とを具備して成り、前記主導体層、側壁用貫通導体群および副導体層で囲まれた領域によって高周波信号を伝送する誘電体導波管線路に対して、上側の前記主導体層に平行に配設された高周波信号を伝送する高周波線路導体を上側の前記主導体層に形成したスロット孔を介して対向させて電磁的に結合させるとともに、前記スロット孔から前記伝送方向に管内波長の略２分の１のｎ倍（ｎは自然数）の位置に、伝送方向の直交方向に前記信号波長の２分の１未満の間隔で前記主導体層間を電気的に接続して形成された端面用貫通導体群と、前記主導体層間に主導体層と平行に形成され、前記副導体層および前記端面用貫通導体群と電気的に接続された端面用副導体層とから成る短絡端を形成し、かつ、前記主導体層間に前記主導体層と平行に前記高周波線路導体に対向させて、一端が前記端面用貫通導体群に電気的に接続され他端が前記スロット孔の下部に至る内部導体層を形成するとともに、前記管内波長の２分の１未満の繰り返し間隔で前記内部導体層の他端と下側の前記主導体層とを電気的に接続する内部貫通導体群を形成したものである。

【００５３】なお、図２においても内部導体層12は一端を端面用副導体層10と一体化させ、両側を副導体層５と一体化させて形成しているが、内部導体層12を形成する高さは副導体層５・10と合わせる必要はなく、また、幅も少なくとも高周波線路導体８に対向する幅があればよい。

【００５４】また、内部導体層12の長さも、内部導体層11と同様に、その他端がスロット孔７の中央から短絡端と反対側に約λｇ／８の位置にくるように形成することが望ましい。

【００５５】なお、端面用貫通導体群９および内部貫通導体群13は側壁用貫通導体群４と同様にして形成すればよく、端面用副導体層10や内部導体層11・12は主導体層２・３や副導体層５と同様にして形成すればよい。

【００５６】また、端面用貫通導体群９および内部貫通導体群13の断面形状や直径等も、側壁用貫通導体４と同様にして形成すればよい。

【００５７】

【実施例】次に、本発明の誘電体導波管線路と高周波線路導体との接続構造の具体例について説明する。

【００５８】比誘電率ε，が4.8のセラミックス材料か

らなる厚みが0.15mmの誘電体層を４層積層して誘電体基板１を構成し、この誘電体基板１に断面のサイズが1.5 mm×0.6 mmの誘電体導波管線路６を形成した。また、その主導体層２に、長さ0.894 mm×幅0.3 mmのスロット孔７を形成するとともに、このスロット孔７から伝送方向に76.5ＧＨｚの高周波信号の管内波長の２分の１の距離にほぼ相当する1.20mmの位置に、端面用貫通導体群９と端面用副導体層10を形成して短絡端を形成した。また、この短絡端からスロット孔７の下部にかけて1.48mmの距離まで主導体層３から0.30ｍｍの高さに内部導体層12を形成し、この端部を内部貫通導体群13により主導体層３と電気的に接続した。

【００５９】そして、高周波線路導体８の線路幅を0.267 mm、誘電体導波線路６と高周波線路導体８とのギャップを0.15ｍｍ、高周波線路導体８のスタブ長（スロット孔７の中心から高周波線路導体８の先端までの長さ）を0.351 mmとして高周波線路導体８をスロット孔７に対向させ、図２に示す本発明の誘電体導波管線路６と高周波線路導体８との接続構造を構成した。

【００６０】そして、この例ならびに誘電体導波管線路６における整合回路部分（内部導体層12および内部貫通導体群13）を設けなかった比較例につき、接続構造の反射係数$S_{11}$をネットワークアナライザにより求めた。その結果を図３に示す。

【００６１】図３は誘電体導波管線路と高周波線路導体との接続構造における反射係数$S_{11}$の周波数特性を示す線図であり、横軸は周波数 FREQUENCY（単位：ＧＨｚ）を、縦軸は反射係数$S_{11}$（単位：ｄＢ）を表わしており、反射係数$S_{11}$の周波数特性を示す特性曲線のうちＡは比較例の特性を、Ｂは本発明の実施例の特性を示している。

【００６２】図３に示す結果より、整合回路部分が無い比較例の結果であるＡにおいては反射係数$S_{11}$は－６ｄＢ程度までにしかならなかったのに対し、本発明の接続構造の結果であるＢによれば、スロット孔７から所定の位置に短絡端を設けるとともに内部導体層12と内部貫通導体群13とにより整合回路部分を設けたことにより、反射係数$S_{11}$が－20ｄＢ以下の良好な特性が得られたことが分かる。このことは、本発明の接続構造にかかる整合回路部分により、誘電体導波管線路６と高周波線路導体８との特性インピーダンスのマッチングが行なわれていることを示すものである。

【００６３】なお、比較例と本発明の実施例とでは反射係数$S_{11}$が最も小さい周波数の位置が若干ずれているが、これは誘電体導波管線路６の短絡端の位置、または内部導体層12の短絡端からスロット孔７下部の端部までの長さ、または内部導体層12の幅を調整することで容易に調整することができる。

【００６４】なお、この本発明の実施例に対して、内部貫通導体群13を形成せず、内部導体層12の高さを0.3 m



mとして図１に示す例における内部導体層11とし、その他は同様にして図１に示す本発明の接続構造を構成して評価したところ、同じく整合回路部分により誘電体導波管線路６と高周波線路導体８との特性インピーダンスのマッチングが行なわれ、反射係数$S_{11}$が－20ｄＢ以下の良好な特性が得られた。

【００６５】なお、本発明は以上の例に限定されるものではなく、本発明の要旨を逸脱しない範囲で種々の変更・改良を施すことは何ら差し支えない。例えば、上記の例では誘電体導波管線路６に対して接続する高周波線路導体８を両者の伝送方向が平行になるように配置した場合を示したが、誘電体導波管線路６に対して高周波線路導体８を直交させても、あるいは任意の角度で交差させてもよく、そのような場合もスロット孔７の位置・形状・寸法等を適宜調整することにより同様の良好な接続特性が得られる。

【００６６】

【発明の効果】以上詳述した通り、本発明の誘電体導波管と高周波線路導体との接続構造によれば、誘電体導波管線路のスロット孔から所定の位置に短絡端を形成するとともに、この短絡端からスロット孔の下部までの間の所定位置に内部導体層を形成し、また、その端部を主導体層と電気的に接続する内部貫通導体群を形成したことにより、この部分によって誘電体導波管線路と高周波線路導体との接続部の特性インピーダンスを変化させて両者の特性インピーダンスマッチングをとることが可能となった。そして、両者の特性インピーダンスを整合させることにより、接続部における高周波信号の反射の発生を充分に低減させ、良好な透過特性を得ることができた。

【００６７】しかも、本発明の接続構造は、このような整合回路部分を有する誘電体導波管線路を例えばグリーンシート積層法等のシート積層技術により容易に作製することができるので、生産性が高く安価に製造することができる。

【００６８】以上により、本発明によれば、積層型の誘電体導波管線路と、他のマイクロストリップ線路やコプレーナ線路等の高周波線路導体とをスロット孔を用いて電磁的に結合し、両者の特性インピーダンスが異なるものであっても良好な特性で接続することができる誘電体導波管線路と高周波線路導体との接続構造を提供することができた。

【図面の簡単な説明】

【図１】本発明の誘電体導波管線路と高周波線路導体との接続構造の実施の形態の一例を示す部分破断斜視図である。

【図２】本発明の誘電体導波管線路と高周波線路導体との接続構造の実施の形態の他の例を示す部分破断斜視図である。

【図３】誘電体導波管線路と高周波線路導体との接続構

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造における反射係数の周波数特性を示す線図である。

【符号の説明】

１・・・・・誘電体基板
２、３・・・主導体層
４・・・・・側壁用貫通導体群
５・・・・・副導体層
６・・・・・誘電体導波管線路

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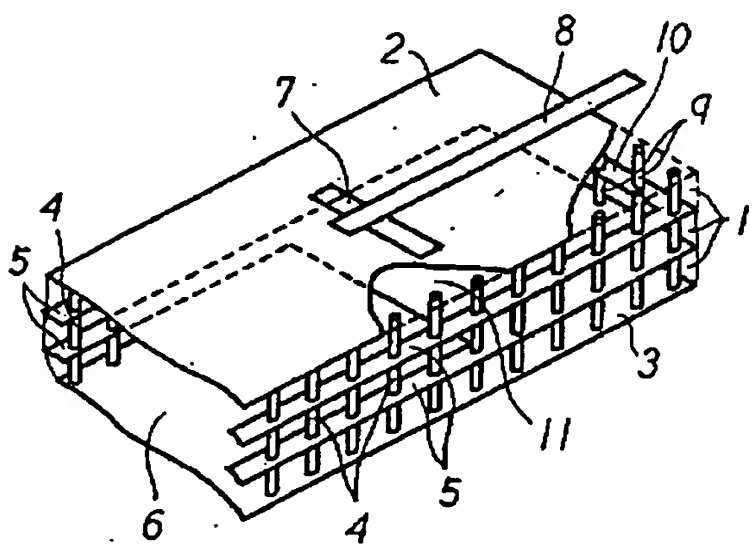
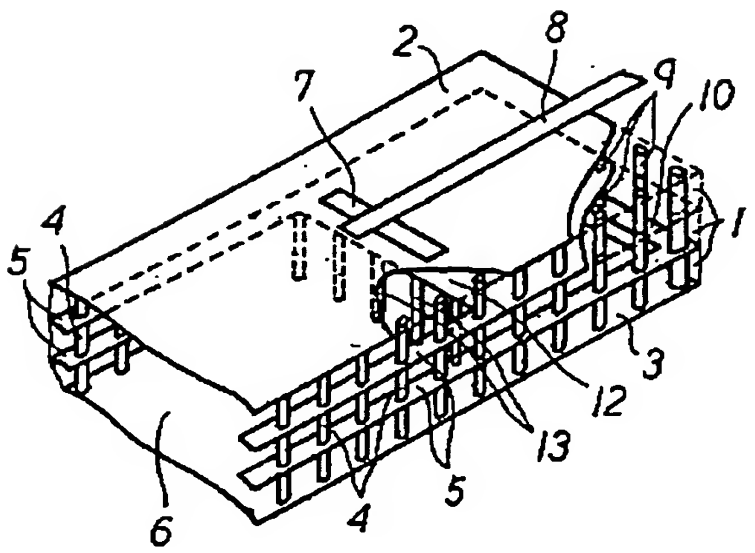
＊７・・・・・スロット孔
８・・・・・高周波線路導体
９・・・・・端面用貫通導体群
10・・・・・端面用副導体層
11、12・・・内部導体層
13・・・・・内部貫通導体群

＊

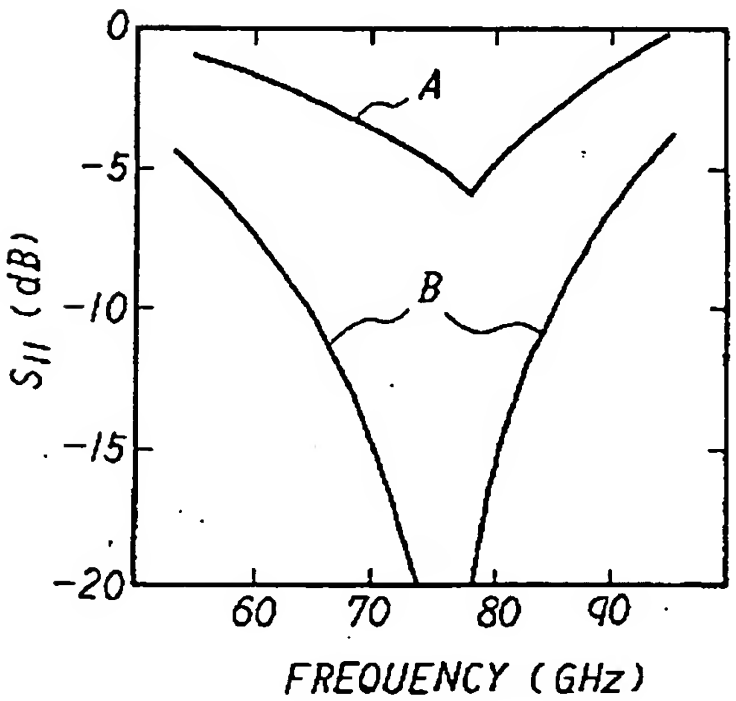
【図１】




【図２】




【図３】



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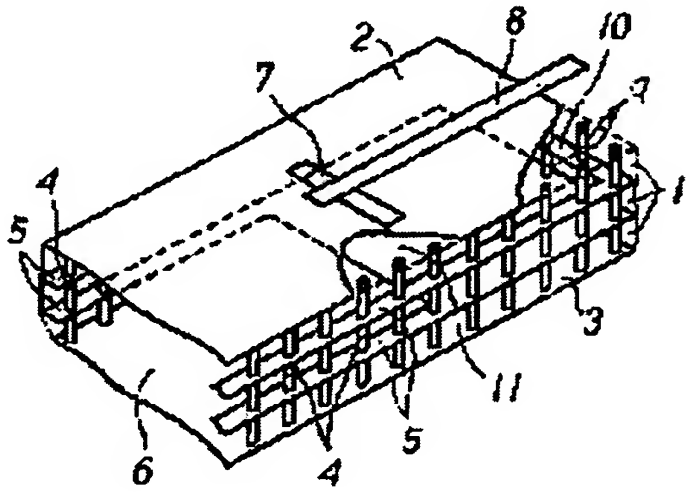
## (54) CONNECTION STRUCTURE BETWEEN DIELECTRIC WAVEGUIDE LINE AND HIGH FREQUENCY LINE CONDUCTOR

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a connection structure between a dielectric waveguide line and a high frequency line conductor electromagntically connecting the stacked dielectric waveguide line and the high frequency line conductor such as other microstrip line or coplanar line through the use of a slot hole 7 while keeping an excellent characteristic even when the characteristic impedance of the both differs.




SOLUTION: The connection structure is configured such that a high frequency line conductor 8 placed opposite to a slot hole 7 is electromagnetically coupled with a dielectric waveguide line 6 provided with main conductor layers 2, 3 clamping a dielectric board 1, two-lines of side wall use through-conductor groups 4, and a sub conductor layer 5 in parallel with the main conductor layers 2, 3, a short-circuit end by end face use through-conductor groups 9 and an end face use sub conductor layer 10 is formed at a position distant from the slot hole 7 of the dielectric waveguide line 6 by about a multiple of n/2 of a guide wavelength in a transmission direction, and an inner conductor layer 11 reaching a lower part of the slot hole 7 from a short-circuit end is formed at a height from the main conductor layer 3 by less than 1/4 of the waveguide length. The characteristic impedance of the connected parts of the both can be matched by using the short circuit end and the inner conductor 11 and the connection structure with an excellent characteristic is realized by suppressing the reflection.

LEGAL STATUS

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* NOTICES *



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CLAIMS

[Claim(s)]
[Claim 1] the penetration for side attachment walls of two trains which connects electrically between the initiative body whorl of the pair which pinches a dielectric substrate, and this initiative body whorl in the transmission direction of a RF signal by less than 1/2 repeat spacing and the predetermined width of face of signal wave length -- a conductor -- with a group it forms in parallel between said initiative body whorls -- having -- said penetration for side attachment walls -- a conductor -- with the subconductor layer of a pair which connects a group electrically, respectively the penetration for end faces which connects between said initiative body whorls crosswise [ said ] electrically at intervals of less than 1/2 repeat of said signal wave length in the abbreviation for the guide wave length n times (n is the natural number) the location of 1/2 in said transmission direction from the slot hole formed in one side of said initiative body whorl, and this slot hole -- a conductor -- with a group this penetration for end faces -- a conductor -- with the subconductor layer for end faces electrically connected with the group and the subconductor layer of said pair said penetration for end faces -- a conductor -- it connecting with a group electrically and on the dielectric-waveguide track which possesses the inner conductor layer formed to the lower part of said slot hole in parallel with the location of the height of under the quadrant of said guide wave length, and consists of another side of said initiative body whorl Connection structure of the dielectric-waveguide track and RF line conductor which are characterized by carrying out the electromagnetic coupling of the RF line conductor which carried out opposite arrangement to said slot hole.
[Claim 2] the penetration for side attachment walls of two trains which connects electrically between the initiative body whorl of the pair which pinches a dielectric substrate, and this initiative body whorl in the transmission direction of a RF signal by less than 1/2 repeat spacing and the predetermined width of face of signal wave length -- a conductor -- with a group it forms in parallel between said initiative body whorls -- having -- said penetration for side attachment walls -- a conductor -- with the subconductor layer of a pair which connects a group electrically, respectively the penetration for end faces which connects between said initiative body whorls crosswise [ said ] electrically at intervals of less than 1/2 repeat of said signal wave length in the abbreviation for the guide wave length n times (n is the natural number) the location of 1/2 in said transmission direction from the slot hole formed in one side of said initiative body whorl, and this slot hole -- a conductor -- with a group this penetration for end faces -- a conductor -- with the subconductor layer for end faces electrically connected with the group and the subconductor layer of said pair an end -- said penetration for end faces -- a conductor -- it connecting with a group electrically and with the inner conductor layer formed to the lower part of said slot hole in parallel with said initiative body whorl the internal penetration which connects electrically the other end of this inner conductor layer, and another side of said initiative body whorl at intervals of less than 1/2 repeat of said guide wave length -- a conductor -- a group on the dielectric-waveguide track which possesses and changes Connection structure of the dielectric-waveguide track and RF line conductor which are characterized by carrying out the electromagnetic coupling of the RF line conductor which carried out opposite arrangement to said slot hole.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the connection structure which connected the dielectric-waveguide track and the RF line conductor electromagnetic through the slot hole especially about the connection structure of the dielectric-waveguide track and RF line conductor which mainly transmit RF signals, such as microwave and a millimeter wave.
[0002]
[Description of the Prior Art] In recent years, research of the mobile communications using RF signals, such as a microwave band and a millimeter wave band, the radar between vehicles, etc. is advanced briskly. As the RF transmission line for transmitting a RF signal in these RF circuits, line conductors, such as a coaxial track, and a rectangular waveguide, a dielectric waveguide, a microstrip line, etc. are known conventionally.
[0003] Moreover, by recently, since two or more arrangement of the RF track where classes, such as the above-mentioned RF transmission line and an antenna element, differ in order to transmit a RF signal in the wiring circuit which constitutes a RF circuit is carried out, the connection technique between these RFs tracks is needed, and the connection structure of various structures is reported about this.
[0004] For example, with connection structure with a coaxial track, a rectangular waveguide, or a dielectric waveguide, it connects by inserting the signal line of a coaxial track into a waveguide, and joining together in RF.
[0005] Moreover, with the connection structure of a waveguide and a microstrip line, when connecting a waveguide and a microstrip line to a right angle, for example, the structure which inserts the dielectric substrate with which the microstrip line was formed in the waveguide is used. Moreover, when connecting a waveguide and a microstrip line in the same transmission direction, the structure which inserts the signal line of a microstrip line in the interior, the structure connected by the electromagnetic coupling which prepared the slot hole in the waveguide or the dielectric waveguide, and minded the slot hole are proposed using the so-called ridge waveguide which narrowed the width of face the shape of a curve toward the edge to which a microstrip line is connected as a waveguide.
[0006]
[Problem(s) to be Solved by the Invention] It continues till recently, and if it forms on the substrate which constitutes a RF circuit, or in a substrate, since it will become advantageous in respect of a miniaturization, to form a dielectric wired waveguide way with a laminating technique in a multilayer-interconnection substrate is desired. For example, in JP,6-53711,A, a dielectric substrate is pinched by the initiative body whorl of a pair, and the waveguide track which formed the side attachment wall by the beer hall group arranged by two trains which connect between initiative body whorls further is proposed. the false conductor according [ this waveguide track ] the four way type of dielectric materials to the initiative body whorl and beer hall group of a pair -- surrounding with a wall -- a conductor -- Kabeuchi's field is made into the track for signal transmissions.
[0007] When mainly using the dielectric-waveguide track of the laminating mold arranged in the interior of such a multilayer-interconnection substrate as the transmission line of the ceramic multilayer-interconnection substrate for microwave and millimeter waves, or the semiconductor

package for high frequency, connection with other high frequency tracks is needed.
[0008] On the other hand, this invention person has already proposed the connection structure using electromagnetic association by the slot hole as shows an outline configuration in drawing A with a partial fracture perspective view in JP,10-107518,A. According to drawing A, the initiative body whorl 2-3 of a pair is formed in the vertical side which faces across a track formation location at least with predetermined spacing on both sides of a dielectric 1 in parallel. In addition, a part of initiative body whorl 2 is fractured and shown so that internal structure may be known. moreover, the penetration which connects them electrically between the initiative body whorls 2-3 -- a conductor -- the group 4 is formed. penetration -- a conductor -- a group 4 has predetermined spacing (width of face), and arranges it in two trains -- having -- and penetration -- each of a conductor is formed in the transmission direction, i.e., track formation direction, of a RF signal with less than 1/2 spacing of signal wave length. thereby -- the initiative body whorl 2-3 and penetration -- a conductor -- the field surrounded by the group 4 serves as the dielectric-waveguide track 5. moreover, the penetration which forms the side attachment wall of the dielectric-waveguide track 5 between the initiative body whorls 2-3 -- a conductor -- it connects with a group 4 electrically, the subconductor layer 6 formed in parallel with the initiative body whorl 2-3 is formed, and the shielding effect of an electromagnetic wave is heightened by making the side attachment wall of a track into the shape of a grid. And among the initiative body whorls 2-3, at least, the slot hole 7 which does not form a conductor in the upper initiative body whorl 2 is formed, and, on the other hand, it connects with RF line conductors (not shown), the dielectric-waveguide track 5, others, for example, a microstrip line etc., etc., through this slot hole 7 here.
[0009] According to this connection structure, by forming the slot hole 7 in a part of initiative body whorl 2-3, an electromagnetic coupling can be easily carried out to other RF line conductors, and the multilayer-interconnection substrate which moreover used the dielectric-waveguide track 5 and it which have this structure can apply the conventional ceramic laminating technique, and can produce it easily.
[0010] However, the characteristic impedance with other RF line conductors connected through the characteristic impedance and the slot hole 7 of the dielectric-waveguide track 5 of such a laminating mold is not usually in agreement. Therefore, in this connection, reflection of the RF signal by the inequality of a characteristic impedance occurred, and there was a trouble that a transparency property also deteriorated in coincidence.
[0011] This invention is thought out in view of the trouble of the above-mentioned conventional technique, and the purpose is in offering the connection structure of a dielectric-waveguide track and a RF line conductor connectable in a good property, even if it combines RF line conductors, such as a dielectric-waveguide track of a laminating mold, and other microstrip lines, a KOPURENA track, electromagnetic using a slot hole and both characteristic impedances differ.
[0012]
[Means for Solving the Problem] As a result of repeating examination to the above-mentioned trouble, while forming the short circuit edge of a dielectric-waveguide track in a position from the slot hole formed in the initiative body whorl of a dielectric-waveguide track, this invention person By forming the inner conductor layer from this short circuit edge to the lower part of a slot hole which counters a RF line conductor and parallel between initiative body whorls, this inner conductor layer functioned as a conductor layer for adjustment of a characteristic impedance, and it found out that the transparency property which was excellent in the connection was acquired.
[0013] Namely, the connection structure of the dielectric-waveguide track of this invention, and a RF line conductor the penetration for side attachment walls of two trains which connects electrically between the initiative body whorl of the pair which pinches a dielectric substrate, and this initiative body whorl in the transmission direction of a RF signal by less than 1/2 repeat spacing and the predetermined width of face of signal wave length -- a conductor -- with a group it forms in parallel between said initiative body whorls -- having -- said penetration for side attachment walls -- a conductor -- with the subconductor layer of a pair which connects a group electrically, respectively the penetration for end faces which connects between said initiative body whorls crosswise [ said ] electrically at intervals of less than 1/2 repeat of said signal wave length in the abbreviation for the guide wave length n times (n is the natural number) the location of 1/2 in said transmission direction

from the slot hole formed in one side of said initiative body whorl, and this slot hole -- a conductor -- with a group this penetration for end faces -- a conductor -- with the subconductor layer for end faces electrically connected with the group and the subconductor layer of said pair said penetration for end faces -- a conductor -- it connecting with a group electrically and on the dielectric-waveguide track which possesses the inner conductor layer formed to the lower part of said slot hole in parallel with the location of the height of under the quadrant of said guide wave length, and consists of another side of said initiative body whorl It is characterized by carrying out the electromagnetic coupling of the RF line conductor which carried out opposite arrangement to said slot hole.

[0014] Moreover, the connection structure of the dielectric-waveguide track of this invention, and a RF line conductor the penetration for side attachment walls of two trains which connects electrically between the initiative body whorl of the pair which pinches a dielectric substrate, and this initiative body whorl in the transmission direction of a RF signal by less than 1/2 repeat spacing and the predetermined width of face of signal wave length -- a conductor -- with a group it forms in parallel between said initiative body whorls -- having -- said penetration for side attachment walls -- a conductor -- with the subconductor layer of a pair which connects a group electrically, respectively the penetration for end faces which connects between said initiative body whorls crosswise [ said ] electrically at intervals of less than 1/2 repeat of said signal wave length in the abbreviation for the guide wave length n times (n is the natural number) the location of 1/2 in said transmission direction from the slot hole formed in one side of said initiative body whorl, and this slot hole -- a conductor -- with a group this penetration for end faces -- a conductor -- with the subconductor layer for end faces electrically connected with the group and the subconductor layer of said pair an end -- said penetration for end faces -- a conductor -- it connecting with a group electrically and with the inner conductor layer formed to the lower part of said slot hole in parallel with said initiative body whorl the internal penetration which connects electrically the other end of this inner conductor layer, and another side of said initiative body whorl at intervals of less than 1/2 repeat of said guide wave length -- a conductor -- it is characterized by carrying out the electromagnetic coupling of the RF line conductor which carried out opposite arrangement at said slot hole on the dielectric-waveguide track which possesses a group and changes.

[0015] While forming a short circuit edge in a position from the slot hole of a dielectric-waveguide track according to the connection structure of the dielectric-waveguide track of this invention, and a RF line conductor the internal penetration which the predetermined location of a before [ from this short circuit edge / the lower part of a slot hole ] is made to counter parallel with a RF line conductor between initiative body whorls, and forms an inner conductor layer in it, and connects that edge with an initiative body whorl electrically -- a conductor -- by having formed the group The effectual thickness of the dielectric-waveguide track of this part will change, and thereby, the characteristic impedance of a connection with a RF line conductor changes, and it becomes possible to take property impedance matching of a dielectric-waveguide track and a RF line conductor. And it becomes the connection structure where fully reduce generating of reflection of the RF signal in a connection, and a good transparency property is acquired, by adjusting both characteristic impedance. and the inner conductor layer which functions as such an adjustment machine and internal penetration -- a conductor -- a group can be manufactured to coincidence in one with a dielectric-waveguide track, and is excellent also in mass-production nature with a conventional ceramic laminating technique and a conventional coincidence baking technique.

[0016]

[Embodiment of the Invention] Hereafter, it explains, referring to a drawing about the connection structure of the dielectric-waveguide track of this invention, and a RF line conductor.

[0017] Drawing 1 is the partial fracture perspective view showing an example of the gestalt of operation of the connection structure of the dielectric-waveguide track of this invention, and a RF line conductor. the penetration for side attachment walls of two trains which the initiative body whorl of the pair to which 1 pinches a dielectric substrate and 2 and 3 pinch the dielectric substrate 1 from the upper and lower sides in drawing 1 , and 4 are less than 1/2 repeat spacing of signal wave length in the direction of a signal transmission, and were formed so that between the initiative body whorls 2-3 of a pair might be electrically connected in the direction of a signal transmission, and the direction which intersects perpendicularly by predetermined width of face -- a conductor -- it is a

group. In addition, a part of initiative body whorl 2 is fractured and shown so that internal structure may be known. 5 [ moreover, ] -- the penetration for side attachment walls -- a conductor -- the penetration which forms each train of a group 4 -- a conductor -- it is the subconductor layer which connects comrades electrically and which was formed in parallel with the initiative body whorl 2-3. 6 -- the initiative body whorl 2-3 of these pairs, and the penetration for side attachment walls -- a conductor -- it is the dielectric-waveguide track formed of a group 4 and the subconductor layer 5.
[0018] Thus, while the initiative body whorl 2-3 of a pair is formed in the vertical side which pinches the dielectric substrate 1 of predetermined thickness and which faces across a transmission-line formation location at least the penetration for side attachment walls of two trains -- a conductor -- a group 4 forms -- having -- **** -- the initiative body whorl 2-3 of this pair, and the penetration for side attachment walls -- a conductor -- by forming the subconductor layer 5 further to the field surrounded by the group 4 if it sees from the interior of the dielectric-waveguide track 6 -- the side attachment wall -- the penetration for side attachment walls -- a conductor -- it becomes the shape of a fine grid and the electromagnetic wave of various directions is covered by a group 4 and the subconductor layer 5.
[0019] The RF line conductor 8 which 7 is the slot hole formed in the upper initiative body whorl 2, and was arranged in parallel with the upper initiative body whorl 2 to this slot hole 7 will be made to counter, when the dielectric-waveguide track 6 and the RF line conductor 8 carry out an electromagnetic coupling through the slot hole 7, it will connect, and a RF signal will be transmitted.

[0020] In addition, in this example, the ground plane to the RF line conductor 8 has composition as which it served by a part of initiative body whorl 2 of the dielectric-waveguide track 6. In this case, it may be air between the RF line conductor 8 and the initiative body whorl 2, or it may be a dielectric. Moreover, the RF line conductor 8 could be formed on another dielectric substrate with which the ground layer was formed in the rear face, and could be formed in the front face of a dielectric substrate with the same interview stratum (KOPURENA track). (microstrip line)
[0021] the penetration for end faces which 9 connected electrically between the initiative body whorls 2-3 in the transmission direction of a RF signal in the rectangular direction of the transmission direction from the slot hole 7 of the dielectric-waveguide track 6 at the abbreviation for guide wave length lambdag n times (-nxlambdag/2 and n are the natural number) the location of 1/2 less than [ of signal wave length ] at intervals of 1/2, and was formed -- a conductor -- it is a group. moreover, 10 is formed in parallel with the initiative body whorl 2-3 between the initiative body whorls 2-3 -- having -- the subconductor layer 5 and the penetration for end faces -- a conductor -- it is the subconductor layer for end faces electrically connected with the group 9. the penetration for these end faces -- a conductor -- by the group 9 and the subconductor layer 10 for end faces, the short circuit edge of the dielectric-waveguide track 6 is formed in the location of - nxlambda g / 2 from the slot hole 7 of the dielectric-waveguide track 6.
[0022] and 11 counters the RF line conductor 8 in parallel with the initiative body whorl 2-3 from the lower initiative body whorl 3 in the location of the height of under the quadrant of the guide wave length of a RF signal -- making -- the end -- the penetration for end faces -- a conductor -- it connects with a group 9 electrically and the other end is the inner conductor layer which results in the lower part of the slot hole 7. Thus, while forming the short circuit edge of the dielectric-waveguide track 6, by having formed the inner conductor layer 11 from that short circuit edge to the lower part of the slot hole 7, a RF signal cannot be invaded between these inner conductor layer 11 bottoms 3, i.e., an initiative body whorl, but result same with having made thin thickness of the dielectric-waveguide track 6 from the slot hole 7 to a short circuit edge is brought. Then, by adjusting the height which forms this inner conductor layer 11, and adjusting width of face and die length, the impedance of the dielectric-waveguide track 6 and the high frequency line conductor 8 can be made to match in a connection, and while fully reducing reflection of the transmission signal in a connection, a good transparency property is acquired.
[0023] The connection structure of the dielectric-waveguide track of this invention of a configuration of being shown in such drawing 1 , and a RF line conductor In the initiative body whorl of the pair which pinches a dielectric substrate from the upper and lower sides, and the transmission direction of a RF signal, at intervals of less than 1/2 repeat of signal wave length and the penetration for side

attachment walls of two trains which connected between said initiative body whorls in said transmission direction and the direction which intersects perpendicularly electrically, and were formed in it by predetermined width of face -- a conductor -- with a group Provide the subconductor layer electrically connected with the group, and it changes. it forms in an initiative body whorl and parallel between said initiative body whorls -- having -- said penetration for side attachment walls -- a conductor -- As opposed to the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group and the subconductor layer said initiative body whorl and the penetration for side attachment walls -- a conductor -- While making the RF line conductor which transmits the RF signal arranged in parallel with said upper initiative body whorl counter through the slot hole formed in said upper initiative body whorl and making it join together electromagnetic the penetration for end faces which connected between said initiative body whorls in the rectangular direction of the transmission direction electrically less than [ of said signal wave length ] at intervals of 1/2, and was formed in said transmission direction from said slot hole at the abbreviation for the guide wave length n times (n is the natural number) the location of 1/2 -- a conductor -- with a group The short circuit edge which consists of the subconductor layer for end faces electrically connected with the group is formed. it forms in an initiative body whorl and parallel between said initiative body whorls -- having -- said subconductor layer and said penetration for end faces -- a conductor -- and said initiative body whorl and parallel are countered from said lower initiative body whorl in the location of the height of under the quadrant of said guide wave length at said RF line conductor -- making -- an end -- said penetration for end faces -- a conductor -- the inner conductor layer to which it connects with a group electrically and the other end results in the lower part of said slot hole is formed.

[0024] In addition, although the inner conductor layer 11 makes an end unite with the subconductor layer 10 for end faces in drawing 1 , and both sides are made to unite with the subconductor layer 5 and being formed, the height which forms the inner conductor layer 11 should just have the width of face to which it is not necessary to double with the subconductor layer 5-10 and, and width of face also counters the RF line conductor 8 at least.

[0025] For example, although the dielectric-waveguide track 6 is constituted from an example shown in drawing 1 by making the dielectric substrate 1 into a three-tiered structure and the inner conductor layer 11 is formed on the dielectric substrate 1 of the 1st layer, the inner conductor layer 11 can be formed in the location of the height of arbitration by adjusting the thickness of each class of a dielectric substrate, or adjusting the number of laminatings.

[0026] Moreover, although set up as die length of the inner conductor layer 11 as a thing from a short circuit edge to the lower part of the slot hole 7, it is desirable to form so that the other end may come for the location of abbreviation lambdag/8 to a short circuit edge and the opposite side from the center of the slot hole 7.

[0027] the penetration for side attachment walls of two trains -- a conductor -- in the transmission direction, i.e., track formation direction, of a RF signal, a group 4 is less than 1/2 predetermined repeat spacing of signal wave length, and is formed in the transmission direction and the direction which intersects perpendicularly with predetermined, fixed spacing (width of face). This forms the electric side attachment wall in this dielectric-waveguide track 6.

[0028] the case where it uses by the single mode although there is especially no limit to spacing between the thickness 2-3 of the dielectric substrate 1, i.e., the initiative body whorl of a pair, here -- the penetration for side attachment walls --.a conductor -- it is good to consider as about 1/2 and about 2 times to the width of face of a group 4. the part to which the part which hits the H plane of the dielectric-waveguide track 6 in the example of drawing 1 is equivalent to the Eth page in the initiative body whorl 2-3 -- the penetration for side attachment walls -- a conductor -- it is formed by the group 4 and the subconductor layer 5, respectively. moreover, the penetration for side attachment walls -- a conductor -- the part to which the part which is equivalent to the Eth page of about 2 times, then the dielectric-waveguide track 6 about the thickness of the dielectric substrate 1 to the width of face of a group 4 hits an H plane in the initiative body whorl 2-3 -- the penetration for side attachment walls -- a conductor -- it will be formed by the group 4 and the subconductor layer 5, respectively.

[0029] moreover, penetration -- repeat spacing of a conductor is set as less than 1/2 spacing of signal

wave length -- the penetration for side attachment walls -- a conductor -- an electric wall can be formed by the group 4. This spacing is under the quadrant of signal wave length desirably.
[0030] Since a TEM wave can be spread between the initiative body whorls 2-3 of the pair arranged in parallel, the penetration for side attachment walls -- a conductor -- the penetration in each train of a group 4, since the clearance will act as a slot and an electromagnetic wave will leak, if repeat spacing of a conductor is larger than 1 (lambda/2)/2 of the signal wave length lambda even if it supplies electric power to this dielectric-waveguide track 6 in an electromagnetic wave -- an electromagnetic wave -- the penetration for side attachment walls -- a conductor -- it leaks from between groups 4 and does not spread along the false waveguide track made here. however, the penetration for side attachment walls -- a conductor -- if repeat spacing of a group 4 is smaller than lambda/2, an electric side attachment wall will be formed, and an electromagnetic wave cannot be perpendicularly spread to the dielectric-waveguide track 6, but it will be spread in the direction of a signal transmission of the dielectric-waveguide track 6, reflecting. consequently -- according to a configuration like drawing 1 -- the penetration for side attachment walls of the initiative body whorl 2-3 of a pair, and two trains -- a conductor -- the field surrounded by a group 4 and the subconductor layer 5 serves as the dielectric-waveguide track 6.
[0031] And those part or all will combine with various RF line conductors 8 which counter the upper part of the slot hole 7 and are arranged through the slot hole 7 formed in the initiative body whorl 2 electromagnetic, and will spread the RF signal which spreads the inside of this dielectric-waveguide track 6.
[0032] the mode shown in drawing 1 -- the penetration for side attachment walls -- a conductor -- although the group 4 was formed in two trains -- this penetration for side attachment walls -- a conductor -- a group 4 -- four trains or six trains -- arranging -- the penetration for side attachment walls -- a conductor -- the false conductor by the group 4 -- forming a wall in three-fold [ a duplex and ] -- a conductor -- the leakage of the electromagnetic wave from a wall can also be prevented more effectively.
[0033] Since it becomes the transmission line by the dielectric waveguide according to such a dielectric-waveguide track 6, it is epsilonr about the specific inductive capacity of the dielectric substrate 1. If it carries out, the waveguide size is 1/rootepsilonr of the usual waveguide. It becomes magnitude. Therefore, specific-inductive-capacity epsilonr of the ingredient which constitutes the dielectric substrate 1 Waveguide size can be made small, and the miniaturization of a RF circuit can be attained and it can consider as the dielectric-waveguide track 6 of magnitude available also as the transmission line of the multilayer-interconnection substrate with which wiring is formed in high density, the package for semiconductor device receipt, or the radar between vehicles, so that it considers as a large thing.
[0034] in addition, the penetration for side attachment walls -- a conductor -- the penetration which constitutes a group 4 -- in order to realize a good transmission characteristic, as for this repeat spacing, considering as fixed repeat spacing is desirable [ the conductor is arranged as mentioned above at intervals of less than 1/2 repeat of signal wave length, and ], but as long as it is less than 1/2 spacing of signal wave length, it may be made to change suitably or some values may be combined.
[0035] Although it does not divide and limit if it has the property which functions as a dielectric and does not bar transmission of a RF signal as a dielectric substrate 1 which constitutes such a dielectric-waveguide track 6, as for the dielectric substrate 1, from the point of the precision at the time of forming the transmission line, and the ease of manufacture, consisting of the ceramics is desirable.
[0036] Although the ceramics with specific inductive capacity various until now as such ceramics is known, in order to transmit a RF signal on the dielectric-waveguide track concerning this invention, it is desirable that they are paraelectrics. Generally this is because as for the ferroelectric ceramics dielectric loss becomes and transmission loss becomes large in a RF field. Therefore, specific-inductive-capacity epsilonr of the dielectric substrate 1 4-100 Extent is suitable.
[0037] Moreover, for the line breadth of the wiring layer generally formed in a multilayer-interconnection substrate, or the package for semiconductor device receipt or the radar between vehicles, specific inductive capacity since it be about 1mm at the maximum be 100. When it use so that the upper part may become the electromagnetic-field distribution which an H plane, i.e., a field,

roll in parallel with an upper field using an ingredient, the minimum frequency which can be used be computed with 15GHz, and become available also in the field of a microwave band.
[0038] The dielectric which consists of resin generally used as a dielectric substrate 1 on the other hand is specific-inductive-capacity epsilonr. Since it is about two, it cannot use, unless it is more than about 100 GHz, when line breadth is 1mm.
[0039] Moreover, although there is much what has a very small dielectric dissipation factor in such paraelectrics ceramics like an alumina or a silica, all paraelectrics ceramics is not available. In the case of a dielectric-waveguide track, there is almost no loss by the conductor, and most loss at the time of a signal transmission is loss by the dielectric. The loss alpha by the dielectric (dB/m) is expressed as follows.
alpha=27.3xtandelta/[lambda/{1-(lambda/lambdac) 2} 1 / 2]
Inside of a formula, tandelta: Dielectric dissipation factor lambda of a dielectric : Wavelength lambdac in a dielectric : When it applies to the rectangular waveguide (WRJ series) configuration by which cutoff wave length standardization was carried out, it is {1-(lambda/lambdac) 2} 1/2 in an upper type. It is about 0.75.
[0040] Therefore, in order to carry out to below -100 dB/m that is the transmission loss with which practical use can be presented, it is required to choose a dielectric so that the following relation may be materialized.
f is the frequency (GHz) of the RF signal to be used among fxepsilon r 1 / 2 xtandelta<=0.8 type.
[0041] As such a dielectric substrate 1, there are alumina ceramics, alumimium nitride ceramic crystallized glass, etc., for example. While the dielectric substrate 1 by these carries out addition mixing of the suitable organic solvent and solvent for example, for ceramic raw material powder and forms it slurry-like The ceramic green sheet of two or more sheets is obtained by adopting a well-known doctor blade method, the well-known calendering roll method, etc. conventionally, and making this with the shape of a sheet. While performing suitable punching processing for each of these ceramic green sheet after an appropriate time, the laminating of these is carried out. In the case of alumina ceramics, in the case of 1500-1700 degrees C and crystallized glass, it is manufactured by calcinating at the temperature of 1600-1900 degrees C in the case of 850-1000 degrees C and the alumimium nitride ceramics.
[0042] Moreover, the initiative body whorl 2-3 and the subconductor layer 5 of a pair for example, when the dielectric substrate 1 consists of alumina ceramics It prints on a ceramic green sheet so that the transmission line may be completely covered at least by thick film printing using what carried out addition mixing of oxides, an organic solvent, solvents, etc., such as a suitable alumina silica magnesia for metal powder, such as a tungsten, and was made into the shape of a paste. After an appropriate time, It calcinates at about 1600-degree C elevated temperature, and as it becomes the thickness of about 5-15 micrometers, it forms. In addition, in the case of crystallized glass, in the case of the alumimium nitride ceramics, as metal powder, tungsten molybdenum is suitable for copper, gold, and silver. Moreover, generally thickness of the initiative body whorl 2-3 and the subconductor layer 5 is set to about 5-15 micrometers.
[0043] moreover, the penetration for side attachment walls -- a conductor -- the penetration which constitutes a group 4 -- a conductor -- for example, a beer hall -- a conductor and a through hole -- what is necessary is just to form with a conductor etc. The cross-section configuration may be polygons, such as a rectangle besides a round shape with easy manufacture, and a rhombus. these penetration -- the metal paste same to the through tube which pierced the conductor for example, to the ceramic green sheet, processed, and was produced as the initiative body whorl 2-3 -- embedding -- the after an appropriate time and dielectric substrate 1 -- simultaneously, it calcinates and forms. in addition, penetration -- a conductor -- diameters 50-300 mum is suitable. Moreover, the slot hole 7 formed in the upper initiative body whorl 2 combines the RF line conductor 8 and the dielectric-waveguide track 6 which counter this and are arranged in the upper part of the initiative body whorl 2 in parallel with the initiative body whorl 2 electromagnetic, and connects a RF signal. A location, the configuration, magnitude, etc. which form this slot hole 7 are set up as follows.
[0044] What is necessary is just to make the configuration of the slot hole 7 into the shape of a rectangle which die length made to 1/2 of signal wave length, and width of face made 1/3 to about 1/10 of die length. Moreover, the location of the slot hole 7 should just have the dielectric-waveguide

track 6 and the RF line conductor 8 in the physical relationship whose electromagnetic coupling is possible with electromagnetic field. In the case of a microstrip line, a KOPURENA track, etc., if not completely [ the RF line conductor 8 / as the longitudinal direction of the slot hole 7 ] parallel, when it is combined and intersects perpendicularly, specifically, it is combined the best.
[0045] And as shown in drawing 1 , it sets on the dielectric-waveguide track 6 concerning the connection structure of this invention. the transmission direction from the slot hole 7 of the dielectric-waveguide track 6 -- the abbreviation for the guide wave length n times (n is the natural number) the location of 1/2 -- the penetration for end faces -- a conductor, while forming the short circuit edge which consists of a group 9 and the subconductor layer 10 for end faces By forming the inner conductor layer 11 which results in the lower part of a short circuit edge to the slot hole 7, in the location of the height of under the quadrant of the guide wave length from the lower initiative body whorl 3 It is the description to form the part which functions on the part from the slot hole 7 to a short circuit edge as a quadrant wavelength matching circuit and which made thickness of the dielectric-waveguide track 6 thin. This can be enabled to adjust the characteristic impedance of this part by adjusting the thickness of a matching circuit part, and the electromagnetic coupling of the RF line conductor 8 with which characteristic impedances differ through the slot hole 7 can be carried out in the condition of low reflection. Adjustment of such thickness of a matching circuit part can be performed by adjusting and preparing the location, and width of face and die length of the inner conductor layer 11.
[0046] Thus, since other various RF line conductors 8 and dielectric-waveguide tracks 6 can be connected with high performance, this matching circuit part is moreover easily produced with sheet lamination techniques, such as a green sheet laminated layers method, in the dielectric substrate which constitutes the multilayer-interconnection substrate for RFs, and the package for semiconductor device receipt for RFs and it can make by having formed the matching circuit part of the dielectric-waveguide track 6, it becomes the connection structure in which manufacture with it is possible. [ high productivity and ] [ cheap ]
[0047] Next, the same partial fracture perspective view as drawing 1 shows other examples of the gestalt of operation of the connection structure of the dielectric-waveguide track of this invention, and a RF line conductor to drawing 2 .
[0048] In drawing 2 , the same sign is given to the same part as drawing 1 . In drawing 2 , replaced with and formed 12 in the inner conductor layer 11 in drawing 1 . An initiative body whorl and parallel are made to counter between the initiative body whorls 2-3 at the RF line conductor 8. It connects with a group 9 electrically and the other end is the inner conductor layer which results in the lower part of the slot hole 7. an end -- the penetration for end faces -- a conductor -- 13 the internal penetration formed so that the other end and the lower initiative body whorl 3 of the inner conductor layer 12 might be electrically connected at intervals of less than 1/2 repeat of the guide wave length of a RF signal -- a conductor -- it is a group.
[0049] such an inner conductor layer 12 and internal penetration -- a conductor -- by having formed the group 13 Even if the height of the inner conductor layer 12 becomes a thing exceeding the quadrant of the guide wave length from the lower initiative body whorl 3 invasion of the transmission signal to the inner conductor layer 12 bottom from the other end side of the inner conductor layer 12 located in the lower part of the slot hole 7 -- internal penetration -- a conductor, since it is prevented by the group 13 Compared with the example of the connection structure shown in drawing 1 , the matching circuit part which was stabilized more electrically and from which the range which can set up the height of the inner conductor layer 12 moreover became wide range can be constituted. By this adjusting the height which forms this inner conductor layer 12, and adjusting width of face and die length, the impedance of the dielectric-waveguide track 6 and the high frequency line conductor 8 can be made to match with fitness more in a connection, and while reducing reflection of the transmission signal in a connection more effectively, a very good transparency property is acquired.
[0050] the internal penetration which constitutes a matching circuit part with the inner conductor layer 12 in such connection structure -- a conductor -- if the group 13 makes the repeat spacing smaller than 1/2 of the guide wave length -- the penetration -- a conductor -- since the leakage of the electromagnetic wave from between will be lost -- internal penetration -- a conductor -- spacing of a

group 13 needs to be less than [ of the guide wave length ] 1/2. in addition -- the example of drawing 2 -- internal penetration -- a conductor -- although the group 13 has been arranged in one train along with the other end of the inner conductor layer 12 -- this -- two or more trains -- you may arrange -- moreover -- being the so-called -- you may arrange alternately.
[0051] Moreover, about the inner conductor layer 12, like the inner conductor layer 11, since the transmission lay length of this inner conductor layer 12 is set to - nxlambda g / 2, this part functions as an adjustment machine of both impedance in the connection of the dielectric-waveguide track 6 and the RF line conductor 8. Consequently, by adjusting the height which forms this inner conductor layer 12, and adjusting width of face and die length, the impedance of the dielectric-waveguide track 6 and the high frequency line conductor 8 can be made to match good in a connection, and while more fully reducing reflection of the transmission signal in a connection, a very good transparency property is acquired.
[0052] The connection structure of the dielectric-waveguide track of this invention of a configuration of being shown in such drawing 2 , and a RF line conductor In the initiative body whorl of the pair which pinches a dielectric substrate from the upper and lower sides, and the transmission direction of a RF signal, at intervals of less than 1/2 repeat of signal wave length and the penetration for side attachment walls of two trains which connected between said initiative body whorls in said transmission direction and the direction which intersects perpendicularly electrically, and were formed in it by predetermined width of face -- a conductor -- with a group Provide the subconductor layer electrically connected with the group, and it changes. it forms in an initiative body whorl and parallel between said initiative body whorls -- having -- said penetration for side attachment walls -- a conductor -- As opposed to the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group and the subconductor layer said initiative body whorl and the penetration for side attachment walls -- a conductor -- While making the RF line conductor which transmits the RF signal arranged in parallel with said upper initiative body whorl counter through the slot hole formed in said upper initiative body whorl and making it join together electromagnetic the penetration for end faces which connected between said initiative body whorls in the rectangular direction of the transmission direction electrically less than [ of said signal wave length ] at intervals of 1/2, and was formed in said transmission direction from said slot hole at the abbreviation for the guide wave length n times (n is the natural number) the location of 1/2 -- a conductor -- with a group The short circuit edge which consists of the subconductor layer for end faces electrically connected with the group is formed. it forms in an initiative body whorl and parallel between said initiative body whorls -- having -- said subconductor layer and said penetration for end faces -- a conductor -- and said initiative body whorl and parallel are countered between said initiative body whorls at said RF line conductor -- making -- an end -- said penetration for end faces -- a conductor, while forming the inner conductor layer to which it connects with a group electrically and the other end results in the lower part of said slot hole the internal penetration which connects electrically the other end of said inner conductor layer, and said lower initiative body whorl at intervals of less than 1/2 repeat of said guide wave length -- a conductor -- a group is formed.
[0053] In addition, although the inner conductor layer 12 makes an end unite with the subconductor layer 10 for end faces also in drawing 2 , and both sides are made to unite with the subconductor layer 5 and being formed, the height which forms the inner conductor layer 12 should just have the width of face to which it is not necessary to double with the subconductor layer 5-10 and, and width of face also counters the RF line conductor 8 at least.
[0054] Moreover, also as for the die length of the inner conductor layer 12, it is desirable to form like the inner conductor layer 11, so that the other end may come for the location of abbreviation lambdag/8 to a short circuit edge and the opposite side from the center of the slot hole 7.
[0055] in addition, the penetration for end faces -- a conductor -- a group 9 and internal penetration -- a conductor -- a group 13 -- the penetration for side attachment walls -- a conductor -- what is necessary is just to form the subconductor layer 10 for end faces, and the inner conductor layer 11-12 like the initiative body whorl 2-3 or the subconductor layer 5 that what is necessary is just to form like a group 4
[0056] moreover, the penetration for end faces -- a conductor -- a group 9 and internal penetration -- a conductor -- a cross-section configuration, a diameter, etc. of a group 13 -- the penetration for side

attachment walls -- what is necessary is just to form like a conductor 4
[0057]
[Example] Next, the example of the connection structure of the dielectric-waveguide track of this invention and a RF line conductor is explained.
[0058] Specific-inductive-capacity epsilonr 4.8 The four-layer laminating of the dielectric layer whose thickness it is thin from a ceramic ingredient is 0.15mm was carried out, the dielectric substrate 1 was constituted, and the size of a cross section formed the dielectric-waveguide track 6 of 1.5 mmx0.6 mm in this dielectric substrate 1. moreover, the location of 1.20mm which is mostly equivalent to 1/2 of the distance of the guide wave length of a 76.5GHz RF signal in the transmission direction from this slot hole 7 while forming the slot hole 7 of die-length 0.894 mmx width-of-face 0.3 mm in that initiative body whorl 2 -- the penetration for end faces -- a conductor -- the group 9 and the subconductor layer 10 for end faces were formed, and the short circuit edge was formed. moreover, the lower part of this short circuit edge to the slot hole 7 -- applying -- up to the distance of 1.48mm -- height of the initiative body whorl 3 to 0.30mm -- the inner conductor layer 12 -- forming -- this edge -- internal penetration -- a conductor -- it connected with the initiative body whorl 3 electrically by the group 13.
[0059] The gap of 0.267 mm, the dielectric wired waveguide way 6, and the RF line conductor 8 for the track width of face of the RF line conductor 8 And 0.15mm, The high frequency line conductor 8 was made to counter the slot hole 7 by having set the stub length (die length from the core of the slot hole 7 to the tip of the high frequency line conductor 8) of the high frequency line conductor 8 to 0.351 mm, and the connection structure of the dielectric-waveguide track 6 of this invention and the high frequency line conductor 8 which are shown in drawing 2 was constituted.
[0060] And it asked for the reflection coefficient S11 of connection structure with the network analyzer about the example of a comparison which did not prepare the matching circuit part (internal penetration a conductor the inner conductor layer 12 and group 13) in this example and the dielectric-waveguide track 6. The result is shown in drawing 3 .
[0061] Drawing 3 is the diagram showing the frequency characteristics of the reflection coefficient S11 in the connection structure of a dielectric-waveguide track and a RF line conductor, and an axis of abscissa is a frequency. The axis of ordinate expresses the reflection coefficient S11 (unit: dB) for FREQUENCY (unit: GHz), among the characteristic curves which show the frequency characteristics of a reflection coefficient S11, A shows the property of the example of a comparison and B shows the property of the example of this invention.
[0062] According to B which it is as a result of the connection structure of this invention, to the reflection coefficient S11 having consisted of a result shown in drawing 3 only by about -6dB in A which it is as a result of the example of a comparison without a matching circuit part while establishing a short circuit edge in a position from the slot hole 7 -- the inner conductor layer 12 and internal penetration -- a conductor -- by having prepared the matching circuit part by the group 13 shows that the good property of -20dB or less was acquired for the reflection coefficient S11. This shows that matching of the characteristic impedance of the dielectric-waveguide track 6 and the high frequency line conductor 8 is performed by the matching circuit part concerning the connection structure of this invention.
[0063] In addition, although the location of a frequency with the smallest reflection coefficient S11 is shifted a little in the example of a comparison, and the example of this invention, this can be easily adjusted by adjusting the location of the short circuit edge of the dielectric-waveguide track 6, the die length from the short circuit edge of the inner conductor layer 12 to the edge of the slot hole 7 lower part, or the width of face of the inner conductor layer 12.
[0064] A group 13 is not formed. in addition, the example of this this invention -- receiving -- internal penetration -- a conductor -- It considers as the inner conductor layer 11 in the example shown in drawing 1 by setting the height of the inner conductor layer 12 to 0.3 mm. When others constituted and evaluated the connection structure of this invention similarly shown in drawing 1 , similarly matching of the characteristic impedance of the dielectric-waveguide track 6 and the high frequency line conductor 8 was performed by the matching circuit part, and the good property of -20dB or less was acquired for the reflection coefficient S11.
[0065] In addition, this invention is not limited to the above example and performing modification

and amelioration various in the range which does not deviate from the summary of this invention does not interfere at all. For example, although the above-mentioned example showed the case where the RF line conductor 8 connected to the dielectric-waveguide track 6 had been arranged so that both transmission direction may become parallel Even if it makes the RF line conductor 8 intersect perpendicularly to the dielectric-waveguide track 6, it may be made to cross at an angle of arbitration, and when adjusting suitably the location, configuration, dimension, etc. of the slot hole 7 also in such a case, the same good connection characteristics are obtained.

[0066]

[Effect of the Invention] While forming a short circuit edge in a position from the slot hole of a dielectric-waveguide track according to the connection structure of the dielectric waveguide of this invention, and a RF line conductor as explained in full detail above the internal penetration which forms an inner conductor layer in the predetermined location of a before [ from this short circuit edge / the lower part of a slot hole ], and connects that edge with an initiative body whorl electrically -- a conductor -- by having formed the group It became possible to change the characteristic impedance of the connection of a dielectric-waveguide track and a RF line conductor, and to take both property impedance matching by this part. And by adjusting both characteristic impedance, generating of reflection of the RF signal in a connection was fully able to be reduced, and the good transparency property was able to be acquired.

[0067] And since the connection structure of this invention can produce easily the dielectric-waveguide track which has such a matching circuit part with sheet lamination techniques, such as for example, a GURI 1 NSHITO laminated layers method, productivity can manufacture it cheaply highly.

[0068] Even if it combines RF line conductors, such as a dielectric-waveguide track of a laminating mold, and other microstrip lines, a KOPURENA track, electromagnetic using a slot hole and both characteristic impedance changes according to this invention with above, the connection structure of a dielectric-waveguide track and a RF line conductor connectable in a good property was able to be offered.

[Translation done.]

## DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the partial fracture perspective view showing an example of the gestalt of operation of the connection structure of the dielectric-waveguide track of this invention, and a RF line conductor.
[Drawing 2] It is the partial fracture perspective view showing other examples of the gestalt of operation of the connection structure of the dielectric-waveguide track of this invention, and a RF line conductor.
[Drawing 3] It is the diagram showing the frequency characteristics of the reflection coefficient in the connection structure of a dielectric-waveguide track and a RF line conductor.
[Description of Notations]
1 ..... Dielectric substrate
2 3 ... Initiative body whorl
4 ..... the penetration for side attachment walls -- a conductor -- a group
5 ..... Subconductor layer
6 ..... Dielectric-waveguide track
7 ..... Slot hole
8 ..... RF line conductor
9 ..... the penetration for end faces -- a conductor -- a group
10 ..... Subconductor layer for end faces
11 12 ... Inner conductor layer
13 ..... internal penetration -- a conductor -- a group

[Translation done.]

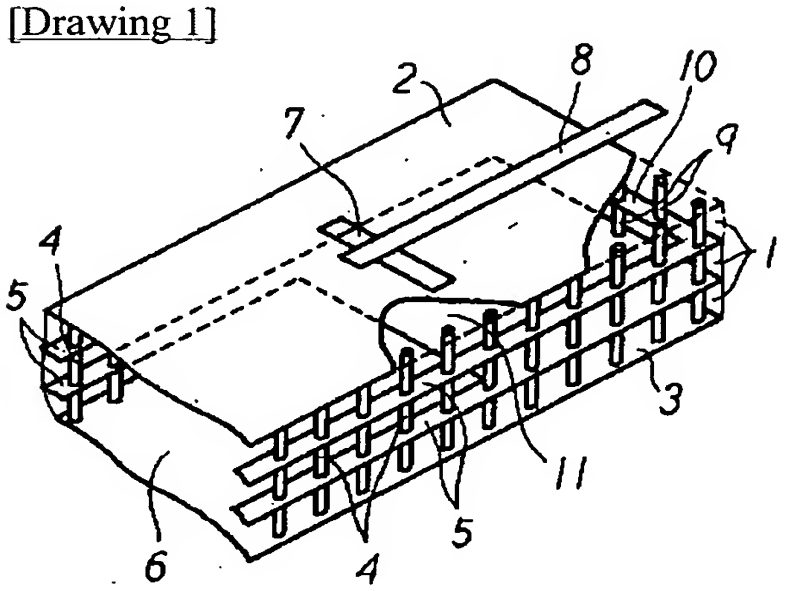
* NOTICES *



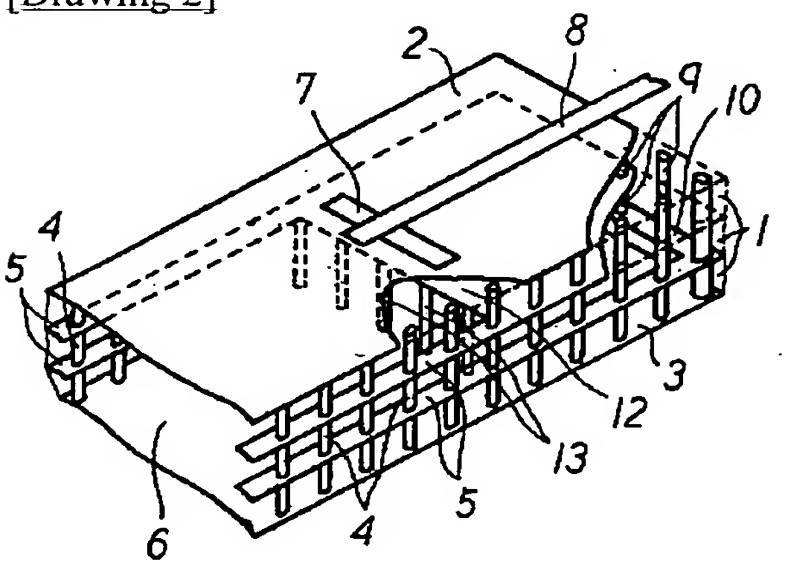
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

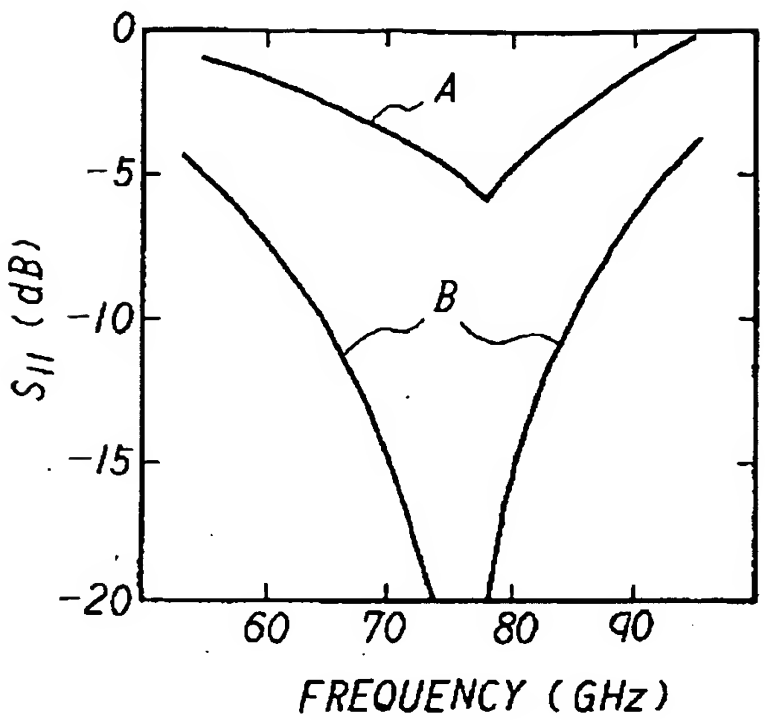
[Drawing 1]




[Drawing 2]




[Drawing 3]




[Translation done.]